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THE SPANISH FLOWER GIRL, FROM MURILLO.

MURILLO AND HIS WORKS. I.

If it be true that painters portray themselves in their works, if their paintings exhibit their own genius, their propensities, affections, and the dispositions of their minds, the works of MURILLO bear a great analogy to his virtues, and the gentleness of his character. That a man of genius should be insensible to those allurements which so greatly affect vulgar minds ought not to excite surprise,—we ought rather to be surprised when a great mind displays the qualities of a mean and narrow capacity. Believing, as we do, in the purifying influence of intellectual exertion, it is cheering to point out the examples which so frequently occur of greatness united to goodness. These qualities ought ever to accompany each other and form the rule, the exceptions to which ought rather to be regarded as accidents insufficient to cast a slur upon the exertions of intellect. We have recently sketched the life of SALVATOR ROSA in which genius and frailty were strangely mingled—a life in which the misery resulting from the gratification of capricious passion was acutely felt. We have also been delighted in the contrast presented by the amiable and accomplished CANOVA, and we now propose to invite attention to the life and works of an artist whose conduct in both has earned for him the title of "the tender and the natural MURILLO."

Bartolomeo Esteban Murillo was born at Seville in 1618. He was descended from an ancient family, who had formerly held ample possessions in the province of Andalusia. Don Juan del Castillo a painter of some celebrity, was his uncle, and had established an academy at Seville which enjoyed considerable reputation.

In common with most persons who have attained eminence in any pursuit, Murillo gave very early indications of the natural bent of his genius. As a child he was constantly filling the margins of his school books, the walls, and whatever paper came into his hands, with drawings. It is not always that parents appreciate justly these promptings of nature, but in the present instance, the parents of Murillo fostered the genius of their child, taught him to read and write, and then took him to the gallery of his uncle Juan to be instructed in the painter's art. Castillo was in high estimation in Seville, being a good designer, although hard and unpleasing in his colouring. The boy was gentle and docile, and soon won the affection of his relative, who led him on slowly and surely in the principles of his art; nor did he leave his pupil ignorant of the mechanical departments—he made him mix his own colours—clean his own brushes—dispose his pallet, and prepare his canvass.

So well did Murillo profit by the instructions of Castillo that in a few years he exhausted all the acquirements of that master. He then painted two pictures, the one in the cloister of the Convent de Regina, representing the Virgin and San Francisco; and the other in another convent, the subject being Our Lady of Rosario with Santo Domingo. The manner of Castillo is discernible in both.

About this time Castillo removed to Cadiz, leaving Murillo without a master and without occupation. He was so poor that being one day in the kitchen of a convent, the cook said, "Murillo, you are so expert, pray do paint something for me." Murillo replied, "I have no canvass, and what is worse, have no money to buy any." The cook held his dish-cloth, Murillo took it and painted the head of Christ upon it, in a beautiful and finished style.

The poverty of our artist compelled him to seek the Feria* in order to paint whatever subjects were ordered of him. Here he continued for some time engaged in supplying wares to this market of Romish saints, and considerably improved his readiness to invent, to draw, and to dispose and arrange any given subject.

After spending a few years in this way, and in private study, a circumstance occurred which had great influence on the mind of Murillo. One of his fellow scholars, Pedro de Moya, influenced by a strong desire to travel in foreign countries, had abandoned the school of Castillo, and gone to Flanders as a private soldier, but happening to see many of the pictures of Vandyck, all his love for his former profession returned, and he was most anxious to become a pupil of that celebrated master. Moya accordingly went to London, where Vandyck resided, became his pupil, and soon succeeded in working in the style of his master; but his improvement was checked by the death of Vandyck, and Moya returned to Spain. Murillo saw, and was surprised at that chaste, and to him hitherto unknown manner, which Moya had acquired, and became anxious to visit Flanders or Italy, in order to obtain the same advantages. But his pecuniary means were very limited,—he was without friends and patrons,—men of greater name or pretension had hitherto stood between him and reputation. But he worked diligently for a short time, and produced several works, which he sold at the Feria, and, without communicating his intentions to any one, he quitted Seville for Italy in the twenty-fourth year of his age.

When Murillo arrived at Madrid he visited his countryman, Don Diego Velasquez de Silva, first painter of the camera to the King, with whom he was not acquainted except by fame, and requested of him letters of introduction to Rome. Velasquez, pleased with the mild and gentle demeanour of Murillo, inquired of him about his connections and family,—of his school and his master,—and the motives which induced him to quit his country, and undertake so distant a journey. Murillo replied with so much ingenuousness that Velasquez was charmed with him,—told him to stay where he was,—to consider Velasquez as his friend, and that house as his home.

Murillo gratefully accepted the generous offer of Velasquez, and proved himself worthy of this liberality by diligent study, and consequent improvement. He copied some paintings of Vandyck, of Ribera, and of Velasquez. These copies Velasquez presented to the king, and they were applauded by all the nobility and connoisseurs of the court. The judicious choice of Murillo was also approved, in selecting three masters celebrated, the one for his exquisite colouring, the other for his perfection in the claro obscuro, and the third for the spirit as well as truth to be seen in his productions; and Murillo was advised to copy no other masters, because these would enable him to attain a good tone of colouring, a facility of handling, and a greater freedom in drawing.

The rapid progress of Murillo surprised his patron, who, after the lapse of about two years, told our artist that he was now qualified to undertake the journey to Rome, and offered him letters of recommendation and other advantages from the King; but, whether actuated by the entreaties of his sister, or that he considered the object attained for which he left Seville, Murillo declined these advantageous offers, and excusing himself in very

* *La Feria* is a name given to a quarter of the parish of Omnium Sanctorum (All Saints) where every Thursday there is held a sale of old and new furniture, second-hand clothes, and numberless articles of cheap purchase. The inhabitants of this district are mostly artists and mechanics, who provide nearly all Andalusia with their productions; especially with pictures, painted generally in so bad a style that every badly-painted picture is named proverbially *Pintura de Feria*. These pictures were formerly executed with so much promptitude, that it happened sometimes that a scripture-piece or a saint which the devout buyer had desired has been painted while the price was being adjusted; or they have transformed, for example, the representation of a Saint Onofre into a Saint Christopher; or the Virgin del Carmen into a Saint Anthony of Padua. The traffic in this sort of pictures, and the speedy execution of them, was formerly very great when the demand for them was large in the Spanish colonies of South America. At that time this description of art was much better executed than in our own days; for many professors having no employment, applied to the freighters to the colonies, who never failed to occupy them, and paid them in proportion to the ability displayed.

We quote this information on the authority of the Spanish writer Cean Bermudez, who has contributed much that is interesting to the biography of Murillo. The biographical notices of this artist collected by Captain Edward Davies will be found interesting.

respectful terms, he acquainted his master and benefactor with his desire to return to Seville. Velasquez regretted this resolution, because he foresaw the high degree of perfection to which Murillo's genius in the art of painting was capable of attaining at Rome, but he did not interfere with his design, and Murillo returned to Seville, in the year 1645.

About this time a proposal was made to adorn the small cloister of the convent of St. Francis, at Seville, with eleven historical pictures, the figures of the full size; but the proposed remuneration was scanty, it being the result of small collections made from the members of the convent, and amounting to so small a sum that all the painters of Seville refused to paint pictures at so mean a price. Murillo, however, who had a reputation to acquire, undertook the work, and his services were accepted simply because those of no other painter were to be had.

The subjects of these pictures were chiefly from the Romish legends, and need not be described. As works of art their character is very high. Murillo worked at them with care and diligence, and the distrust of his employers was gradually converted into the most hearty gratification and delight. But the astonishment of the artists and connoisseurs of Seville knew no bounds: here were eleven fine pictures, arranged and executed without the knowledge of any one of these "directors of the public taste," and by an artist whom no one had heard of: suffice it to say that in a short time Murillo was acknowledged as the chief of the Sevillian school, because the genius of the painter enabled him to appeal to the feelings and affections of our common nature, by presenting truth in all her simple purity.

Murillo now became celebrated: the great, the powerful, and amateurs in art courted his intimacy, and desired to be painted by him. His rising talents procured him an introduction to Doña Beatriz de Cabrera y Solo Mayor, a lady of distinction and fortune at Pilas, to whom he was married in the year 1648. Murillo now became one of the most distinguished citizens of Seville, and his house was the resort of persons of influence, of taste, and talent in the arts.

The frontispiece to our present article is copied from a picture in the Dulwich Gallery, which is commended by Dr. Waagen in the following terms:—"A girl, with great simplicity of expression, holds some roses in her handkerchief,—a choice example of the very peculiar contrasts and accords of colours by which many of Murillo's pictures have such a magical effect. The background a landscape."

CASHMERE SHAWLS.

I.

The Goat of Cashmere, and the Native Manufacture.

Cashmere has been celebrated from very early periods, for the beauty of its situation, the comeliness of its inhabitants, and the products obtained thence. It is the name both of a country and the capital city therein. The country is a fertile valley, entirely inclosed by lofty mountains, in the north-west extremity of India. The countries which surround it are those of the Seiks, of the Afghans, of the Tibetians, and of the Chinese Tartars. It appears in early ages to have had Hindoo sovereigns, but to have been conquered by a Mohammedan usurper about five or six hundred years ago. The next conqueror was the Mogul emperor of Hindostan, Humayoon, in whose family the sovereignty remained till the rise of the powerful Afghan dynasty in the last century, when Cashmere became a province of Afghanistan. During the present century, when the contests of rival claimants to the Afghan crown had reduced the monarchy to a shadow, Runjeet Singh, the powerful chief of the Seiks, seized Cashmere; and we believe that it still remains under the sovereignty of his successor.

Throughout this series of changes, Cashmere appears to have been highly valued, on account of the large revenue derivable from its produce. The city of Cashmere is very large, containing nearly two hundred thousand inhabitants; but the feature for which the valley has been prized is the great productiveness of the soil, and also the productive industry of the inhabitants. The Cashmerians have become celebrated, not only throughout Asia, but in Europe likewise, for the beautiful *shawls* which they produce. At the time when the Honourable Mountstuart Elphinstone visited the Afghan dominions, Cashmere was considered to possess sixteen thousand shawl-looms, each giving employment to three men. A recent writer in the *Encyclopædia Britannica* remarks:—"For a long period the district of Cashmere, a province of Hindostan, formerly subject to the King of Candahar (Caubul), produced articles of this description in such perfection as to make them highly prized both in Europe and Asia. The date at which this manufacture took its rise is not known; but ever since the British established themselves in India, Cashmere shawls have been considered one of the most valuable manufactures of the East. These shawls are made both long and square, the former measuring generally fifty-four inches wide and a hundred and twenty-six long; the latter are from sixty-three to seventy-two inches square. The finest of them are composed of a material exquisitely soft and warm, surpassing in this respect probably any other material that has ever been fabricated into clothing." From the observations of Bernier, Strachey, and other writers, we gather the following particulars respecting the mode of manufacturing the shawls, as well as the general arrangements connected with the manufacture, in Cashmere.

It appears that the shops occupied by the shawl makers consist of a frame-work, at which the persons employed sit on a bench. The number employed on one shawl is two, three, or four; generally three. On plain shawls two persons only are employed, the weaving being effected with a long, narrow, and heavy shuttle; but those shawls of which the pattern is variegated are worked with wooden needles instead of a shuttle, there being a separate needle for the thread of each colour. The operations are consequently slow, proportionate to the quantity of work which the pattern may require. It is not unusual for a shop to be occupied with the manufacture of one single shawl for a whole year, if it be a remarkably fine one; and, in those which are most elaborately worked, not one quarter of an inch is completed in one day by three persons. Sometimes, in order to expedite the production of a shawl, it is made in separate pieces at different looms, and the worked pieces are afterwards sewed together.

The Oostand, or head workman at each loom, superintends the operation on the shawl, while the other persons are employed near him immediately under his direction. Should the pattern which is about to be worked in the shawl be new, or one with which the workmen are not familiar, the Oostand directs them as to the figures, colours, and threads, which they must employ; keeping before him a paper pattern of the device which is to be produced. During the operation of making, the rough or inferior side of the shawl is uppermost on the frame, or nearest the eye; notwithstanding which, the Oostand preserves the pattern with the utmost accuracy. The mode of operation in this respect seems to bear considerable resemblance to the mode of producing tapestry in the old times, when the rooms of the noble and the wealthy were hung with that production instead of with painted or printed paper.

A merchant who enters largely into the traffic in shawls, frequ ntly engages a number of shops, situated near one spot, where he employs men to work for him;

or else he supplies the Oostands or head workmen with thread which has been previously spun by women and afterwards dyed, and they carry on the manufacture at their own houses, having previously received instructions from the merchant respecting the quality of the goods he may require, their colours, patterns, &c. Under such circumstances, the employer finding all the materials, an Oostand receives from six to eight *pice* per day as wages, and a common workman from one to four *pice*,—a *pice* being a small coin in Cashmere, worth about three half-pence English money. After the shawls are completed, the merchant sends them to the custom-office, where each shawl is stamped; and he there pays a certain duty, the amount of which varies with the quality and value of the shawl. The duty is reckoned at one-fifth of their value; but the government-officers generally manage to fix the value at more than the goods are really worth, for the purpose of increasing the per-centage payable into the treasury of the state. In most Eastern countries, where a province is governed by a pacha, a satrap, a zemindar, or other vice-regal personage, the amount of duty levied on merchants and traders is too often left at the mercy of the governor, who seldom fails to appropriate a portion to his own private use.

The wool of which the Cashmere shawls are made is imported principally from Tibet and Tartary, in which countries the kind of goat which produces this wool thrives better than in most others. That which is brought from Rodauk is deemed the best, its price in Cashmere being from ten to twenty rupees for a *turruk* of twelve pounds. It is to the peculiar beauty and fine texture of this wool that the Cashmere shawls owe the high estimation in which they are held. The wool forms the inner coat with which the goat is covered; and the dark gray colour which belongs to it in a natural state, is removed from it by a bleaching process to which it is subjected in Cashmere, and which is effected principally by a preparation of rice-flour. When this bleaching has been completed, the wool is spun into yarn, and dyed of various colours. The weaving then proceeds, in the frames of which we have before spoken; and, after being woven, the piece is washed once; and the border, in which is displayed a variety of figures and colours, is attached to the shawls in so dextrous a manner that the junction can scarcely be detected. The price varies, under ordinary circumstances, from a sum equal to about ten shillings English, up to fifty; but when the flowered work is unusually elaborate, the price is increased to five or six pounds. This rate of charge does not appear large, to us who are familiar with British manufacture; but, when we take into account the very small daily wages of these Cashmere weavers, the proportionate price is then considerable.

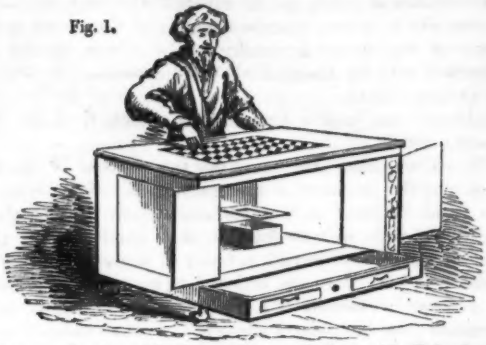
When Cashmere was tributary to Afghanistan, a considerable portion of the public revenue was exacted in shawls, instead of money. Many of the shawls are exported in an unwashed state, and in the western parts of Asia they are worn also in that state; but in India there is no market for unwashed shawls, and therefore they are washed and packed at Umritsir, a town near Lahore, where the process of washing is more carefully attended to than at Cashmere.

With regard to the extent of the shawl manufacture in Cashmere, nothing more than an approximate estimate can be made. Two hundred years ago, it was supposed that there were forty thousand looms in Cashmere. Mr. Strachey, however, in 1809, stated the number at sixteen thousand; and adds, "It would perhaps be difficult to determine with accuracy the quantity of shawls manufactured annually; supposing, however, that five of all kinds are on an average made at each shop or loom in the course of a year, the number would be eighty thousand, which is probably not far from the truth."

ON CHESS. No. XIII.

THE AUTOMATON CHESS-PLAYER. I.

Fig. 1.



A perspective view of the Automaton, seen in front, with all the doors thrown open.

PROBABLY no contrivance of the fertile genius of man ever excited so much wonder and delight for upwards of half a century as the Automaton Chess-player. The announcement and subsequent production of a machine which appeared so to vary its operations and modes of action as to suit the ever-varying circumstances of a game of chess were sufficient to account for this excitement throughout Europe.

The results of automatic machinery in general cease to interest the mind strongly so soon as the effects produced by it are clearly traced to well-established physical causes. The wind which turns the sails of a windmill; the flowing stream which gives motion to a water-wheel; and the elastic steam which elevates and depresses alternately a piston, are simple results of self-evident causes. These prime movers may impart motion to more or less complicated machinery, so as to produce the variegated carpet which adorns our rooms, or the sheet of paper upon which we write, but still the mind is satisfied that these results are produced by machinery in motion, which motion is imparted and sustained by some well-known force. So also in machines which imitate many of the motions and attributes of animals the mind is soon satisfied that the cause is mechanical, and resides within the automaton itself, since by a slight observation it is seen that the automaton is adequate to the performance only of a very limited routine of actions which are always repeated, like the tunes on a barrel-organ, in the same order.

Automata may be divided into three classes,—VIZ., the *simple*, the *compound*, and the *spurious*. The first class comprises those insulated automata, the movements of which result from mechanism alone, by the aid of which they perform certain actions, and continue them so long as the moving force is kept in an active state. As examples we may cite the trumpeter of Maelzel, the flute-player of Vaucanson, the self-acting piano-forte, * &c.

The second class includes those automata which, like the former are moved by machinery, but possessing at the same time a secret communication with human agency, are enabled to change the regular order and succession of their movements according to existing circumstances, and hence in some manner to assume the character of living beings.

The third class contains those automata which, under the semblance only of mechanism, are wholly directed and controlled by a concealed human agent.

Now it must be at once perfectly clear to every intelligent reader that the Automaton Chess-player cannot belong to the first class, because, great and surprising as the powers of mechanism assuredly are, the movements which result from it are necessarily limited and uniform. Those who know anything of the difficulties and intricacies of chess will readily admit that intellect, and that

* This class of Automata is described in *Saturday Magazine* Vol. XVIII., pp. 62 and 69.

of no mean order, is alone equal to the task of managing this game; that machinery can never usurp and exercise the faculties of mind, and therefore that the Chess Automaton, which in its day encountered, and often conquered, some of the first-rate professors of chess, cannot be admitted into the class of *simple* automata. Its claims to a place either in the second or in the third division the reader will easily decide upon after a perusal of the following details.

The Chess Automaton was the invention of Wolfgang de Kempelen, a native of Hungary, Aulic councillor to the royal chamber of the domains of the Emperor of Germany, and celebrated for his skill in mechanics. In the year 1769 de Kempelen, being at Vienna on business relative to his office, was ordered to court to be present as a scientific witness of some magnetic games or performances which one Pelletier, a Frenchman, was to exhibit before the Empress Maria Theresa. During the exhibition, Her Majesty having condescended to enter into familiar conversation with de Kempelen, he was induced to hint that he thought himself capable of making a machine, the effects of which would be more surprising, and the deception more complete than anything Her Majesty had seen during this magnetic exhibition. The empress took him at his word, and expressed so earnest a desire to see his project carried into execution that she obtained a promise of him to set about it immediately. He kept his word, and in six months again appeared at the Court of Vienna in company with the Automaton Chess-player.

It may readily be supposed that this automaton excited the admiration and surprise of every one who either saw it play or played with it. An account of the invention soon spread through a great part of Europe; the newspapers and journals were eager to announce its marvellous powers; the smallest scrap of information respecting it was read with avidity; and the result of all this excitement was that these accounts become daily more exaggerated and contradictory. Even an intimate friend of the inventor, who had repeated opportunities of witnessing the performances of the automaton, expresses himself in the following high-flown terms.

The boldest idea that ever entered the brain of a mechanic was doubtless, that of constructing a machine to imitate man, the master-piece of the Creation, in something more than figure and motion. M. de Kempelen not only conceived this idea, but also carried it into execution; his Chess-player being beyond contradiction the most astonishing automaton that ever existed. Never before did any mere mechanical figure unite the *vis motrix* with the *vis directrix*, or to speak more clearly, the power of moving itself in different directions as circumstances unforeseen and depending on the will of any person present might require. Was a wooden figure ever before seen playing at the most difficult and complicated of all games, frequently beating the most consummate adept, and setting him right if ever he deviated from the rules of the game?

The same writer published a series of letters to a friend descriptive of all the "externals" of the Chess Automaton*. These letters are extremely interesting, not only on account of the admiring simplicity with which he speaks of the invention of his friend; but for the information they give as to the mode of exhibition adopted by de Kempelen from the very first. Our author writes to a friend at a distance from Vienna, and begs him to set bounds to his curiosity, "for he cannot gratify it;" and although he admits the automaton "must be a deception," yet "he is forced to the humiliating avowal that it is as incomprehensible to himself as to the person he addresses." He is, however, kept in countenance by the fact that "others endowed with much superior knowledge and quicker penetration have not been more successful than himself in developing the mystery." And then growing warm with his subject he exclaims, "It is a deception!—granted: but such an one as does honour to human nature; a deception more beautiful, more surprising, more astonishing than any to be met with in the different accounts of mathematical recreations."

In our next article on this subject we will describe particularly the appearance and performances of the Chess Automaton. We will conclude our present notice with two extracts from the author already quoted.

The first idea that strikes you on a superficial examination of this chess-player is a suspicion that its movements are effected by the immediate impulse of some human being. I myself fell into this mistake. When I first saw the inventor shove his automaton, fixed to a kind of large cupboard, out of an alcove, I could not any more than the rest of the company avoid suspecting that this cupboard certainly contained a child, which from the size of it I supposed might be from ten to twelve years old. Many of the company were so fully persuaded of it that they made no scruple to declare it. I assented only in silence to their opinion, but was not less confused when I saw M. de Kempelen tuck up the dress of the automaton, take out the drawers, and open all the drawers of the cupboard, and in this situation roll it round the room on the castors which it goes upon, turning it in every direction so as to enable each person present to examine it on all sides. You may be sure that I was not a little eager to gratify my curiosity. I examined even the minutest corner of it, without being able to find anything throughout the whole capable of concealing an object the size of my hat. My vanity was grievously mortified to see my hypothesis, which at first sight appeared so plausible, instantaneously disproved.

I know not whether the whole company were affected in the same manner: but I thought I could perceive in many of their countenances marks of the greatest surprise. One old lady in particular who had not forgotten the tales told her in her youth, crossed herself, and sighing out a pious ejaculation went and hid herself in a window seat, as distant as she could from the *evil spirit*, which she firmly believed possessed the machine.

Our author being thus fairly put upon a wrong scent has recourse to the idea of a secret communication between the automaton and some neighbouring apartment. This leads him to describe the residence of M. de Kempelen thus—

M. de Kempelen resides here at Presburg, and occupies with his family the first floor of his house; his little workshop together with his study where the automaton is placed, are on the second floor. When the automaton is exhibited, the company assemble in the lower apartment, from whence they are conducted up stairs. In passing through the workshop which serves as an antechamber to the study, you see nothing but joiner's, smith's and clockmaker's tools, lying in heaps in that confusion so characteristic of the abode of a mechanical genius. The walls of the study are in part hid by large presses, some containing books, others antiques, and the remainder a small collection of natural history: the intermediate spaces are decorated with paintings or prints, the performances of the master of the house.

The writer satisfies himself that no communication can possibly exist between the automaton and an adjoining room; this was indeed proved by the machine being carried for exhibition to the Imperial Palace.

Fig 2.

An elevation of the Automaton, as seen from behind.

* The title of this book is remarkable, and displays the spirit of credulity with which it was written. It is as follows:—INANIMATE REASON; *or a circumstantial Account of that astonishing piece of Mechanism, M. de Kempelen's Chess-player.* By M. CHARLES GOTTLIEB DE WINDISCH. This gentleman is spoken of, elsewhere, as the respectable author of *The History and Geography of the Kingdom of Hungary*, and the intimate friend and countryman of M. de Kempelen.

AGRICULTURAL CHEMISTRY.

I. On the Interchange of Crops.

At one of the meetings of the Chemical Section of the British Association for the advancement of Science, the preparation of a Report on Organic Chemistry was assigned to Dr. Justus Liebig, Professor of Chemistry in the University of Giessen. This Report has been edited by Dr. Lyon Playfair, and recently published under the title of "Organic Chemistry, in its applications to Agriculture and Physiology." From this work, which is one of the most profound and useful contributions to science, we propose to select a few subjects capable of being presented to the reader in a popular form.

It has long been known to the agriculturist that the growth of annual plants is impeded, and the produce rendered less abundant, by cultivating them during successive years on the same soil, and that, notwithstanding the loss of time, a larger quantity of grain is obtained when a field is allowed to remain uncultivated for a year. During this interval of repose, the soil, in a great measure, regains its fertility.

Experience has also led to the observation that certain plants, such as peas, clover, and flax, flourish on the same soil only after a lapse of years; whilst others, such as hemp, tobacco, rye, and oats, may be cultivated in close succession. It has been also found that several of these plants improve the soil, whilst others, and these are the most numerous, impoverish or exhaust it. Fallow turnips, cabbage, beet, spelt, summer and winter barley, rye, and oats, are supposed greatly to impoverish the soil; whilst wheat, hops, madder, late turnips, hemp, poppies, teasel, flax, weld, and licorice, are supposed to exhaust it entirely.

From the earliest times manure has been employed to increase the fertility of soils; and experience has proved that manures restore certain constituents to the soil, which have been removed by the plants grown upon it; but it has been observed that crops are not always abundant in proportion to the quantity of manure employed, even, although it may have been of the most powerful kind: that the produce of many plants diminishes in spite of the apparent replacement of the substances removed from the soil by manure, when they are cultivated on the same field for several years in succession.

It has been remarked, on the other hand, that a field which has become unfitted for a certain kind of plants was not on that account unsuited for another; and, upon this observation, a system of agriculture has been gradually formed, the chief object of which, is to obtain the greatest possible produce with the least expense of manure.

It was deduced from the foregoing facts that plants require for their growth different constituents of soil, and it was very soon perceived that an alternation of the plants cultivated maintained the fertility of a soil, quite as well as leaving it at rest or fallow. It was evident, therefore, that all plants must give back to the soil in which they grow, different proportions of certain substances, which are capable of being used as food by a succeeding generation.

Many explanations have been offered respecting the cause of the favourable effects of the alternation of crops; but the theory of De Candolle is the one which has received the greatest share of attention.

This distinguished botanist supposes that the roots of plants imbibe soluble matter of every kind from the soil, and thus necessarily absorb a number of substances which are not adapted to the purposes of nutrition, and must subsequently be expelled by the roots, and returned to the soil as excrements. Now, as excrements cannot be assimilated by the plant which ejected them, the more of these matters which the soil contains, the more unfertile must it be for plants of the same species. These excrementitious matters may, however, still be capable of assimilation by another kind of plants, which would thus remove them from the soil, and render it again fertile for the first. And, if the plants last grown also expel substances from their roots, which can be appropriated as food by the former, they will improve the soil in two ways.

This view of the subject is countenanced by many well-known facts. Every gardener knows that a fruit-tree will not grow on the same spot, where another of the same species has stood; at least not till after a lapse of several years. Before new vine-stocks are planted in a vineyard from which the old have been rooted out, other plants are cultivated on the soil for several years. It has also been remarked, that several plants thrive best when growing beside one another; and, on the contrary, that others mutually prevent each other's growth. Whence it was concluded, that the beneficial influence in the former case depended on a natural interchange of nutriment between the plants, and the injurious one in the latter on a poisonous action of the excrements of each on the other respectively.

But the theory of M. De Candolle has been confirmed in a satisfactory manner by a series of admirable experiments by M. Macaire which we will briefly detail.

The roots of the *Chondrilla muralis* were carefully cleaned and immersed in filtered rain water: the plant continued to flourish, and put forth its blossoms, and at the end of eight days the water was of a yellowish colour, indicating to the smell and taste the presence of a bitter narcotic substance, similar to that of opium,—a result which was further confirmed by using chemical tests, and by a reddish-brown residuum which remained after evaporating the water. It was ascertained that neither the roots nor stems of the same plants, when completely detached and placed in water could produce this effect, which seems to be the result of an exudation from the roots, necessary to the health of the plant. By comparing the results of various experiments on the quantity of matter thrown off by the roots of the French bean, by night and by day, it was found to be much more considerable by night,—an effect which it is natural to refer to the interruption of the action of the leaves when deprived of light, and when the corresponding absorption by the roots is also suspended. This was confirmed by the result of some experiments made on the same plants by placing them during the day in a darkened room, when the excretion from the roots was found to be much increased; but, even when exposed to the light, there is always some exudation, though in small quantity, going on from the roots.

By this excretory process plants are enabled to get rid of any noxious matters which they may have absorbed from the soil. This was proved by experiments on several plants, among which was the common cabbage. The root of the cabbage was washed clean, and the fibres separated into two bunches, one of which was immersed in a weak solution of acetate of lead, and the other bunch in pure water, contained in a separate vessel. After a few days, during which the plants vegetated tolerably well, an appreciable quantity of acetate of lead was found in the vessel which contained at first only pure water. In order to prove that the poison was actually absorbed into the body of the plant the experiment was varied: the plant was first allowed to remain with its roots immersed in a solution of acetate of lead: it was then removed and carefully washed, in order to get rid of all traces of the solution from the surface of the roots, after which it was placed in a vessel containing pure water, which in two days' time became contaminated with acetate of lead. Similar results were obtained when lime-water and a solution of common salt were substituted for the acetate of lead.

M. Macaire also found that the water in which certain plants had been kept was injurious to other plants of the same species, while it produced decidedly beneficial effects on plants of a different kind.

When substances which cannot from their nature be employed in the nutrition of a plant exist in the matter absorbed by its roots they must be again returned to the soil as excrements, which, however, may be serviceable, or even indispensable, to the existence of several other plants. Substances, however, that are formed by the vegetable organs during the process of nutrition, which are produced in consequence of the formation of woody fibre, starch, albumen, gum, acids, &c., cannot again serve in any other plants to form the same constituents of vegetables.

The matter thrown off by the roots of plants as excrements, undergoes during autumn and winter a useful change from the action of air and water: its putrefaction, and at length by continued contact with the air, which tillage is the means of procuring, its decay, are effected; and at the commencement of spring it has become converted, either in whole or in part, into a substance which supplies the place of humus*, by being a constant source of carbonic acid.

The quickness with which this decay of the excrements of plants proceeds, depends on the composition of the soil, and on its greater or less porosity. It will take place very quickly in a calcareous soil; but it requires a longer time in heavy soils, consisting of loam or clay.

The same plants can be cultivated with advantage on one soil after the second year, but in others not until the fifth or ninth, merely on account of the change and destruction of the excrements, which have an injurious influence on the plants, being completed in the one, in the second year; in the others not until the fifth or ninth.

In some neighbourhoods clover will not thrive till the sixth year; in others not till the twelfth; flax in the second or third year. All this depends on the chemical nature of the soil; for it has been found by experience, that in those districts where the intervals at which the same plants can be cultivated with advantage are very long, the time cannot be shortened even by the use of the most powerful manures. The destruction of the peculiar excrements of one crop must have taken place before a new crop can be produced.

Flax, peas, clover, and even potatoes, are plants, the excrements of which in clayey soils require the longest time for their conversion into humus; but the use of alkalies and burnt lime, or even small quantities of wood ashes, (which have not been wetted so as to remove the alkali contained in them,) must enable a soil to permit the cultivation of the same plants in much less time.

A soil lying fallow owes its earlier fertility, in part, to the destruction or conversion into humus of the excrements contained in it, which is effected during the fallow season, at the same time that the land is exposed to a further disintegration. In the soils in the neighbourhood of the Rhine and Nile, which contain much potash, and where crops can be obtained in close succession from the same field, the allowing of the land is superseded by the inundation. The artificial irrigation of meadows effects the same purpose. It is because the water of rivers and streams contains oxygen in solution, that it effects the most complete and rapid putrefaction of the excrements contained in the soil which it penetrates, and in which it is continually renewed. If it was the water alone which produced this effect, marshy meadows should be the most fertile.

A fertile soil ought to afford to a plant all the inorganic bodies necessary to its existence in sufficient quantity and in such condition as allows their absorption. All plants require alkalies, and these are contained in some plants (as in the grasses) in the form of silicates; in others in the form of tartrates, citrates, acetates, or oxalates. Some species of plants require phosphate of lime, or phosphate of magnesia, and several do not thrive without carbonate of lime.

* Woody fibre, in a state of decay, is called *humus*, and is the principal constituent in mould. Humus acts in the same manner in a soil permeable to air as in the air itself; it is a continued source of carbonic acid, which it emits very slowly. An atmosphere of carbonic acid formed at the expense of the oxygen of the air surrounds every particle of decaying humus. The cultivation of land by tilling and loosening the soil, causes a free and unobstructed access of air. An atmosphere of carbonic acid is therefore contained in every fertile soil, and is the first and most important food for the young plants which grow in it.

THE PANDEAN PIPES, OR MOUTH-ORGAN.

> The rural ditties were not mute,
> Tempered to the oaten flute,
> Rough satyrs danced, and fauns with cloven heel
> From the glad sound would not be absent long,
> And old Damœtas loved to hear our song.——MILTON.

AMONG the musical instruments familiarly known to us at the present day, there is one which, though it has acquired a sort of a character for vulgarity, is one of the most ancient of all. We allude to the *Mouth-organ*, known to classical readers by the names *Syrinx*, and *Fistula Panis*, or Pan's Pipes.

The formation and the mode of playing musical instruments among the ancients have formed the subject of considerable research; great difficulty being experienced in knowing the proper interpretation or translation to be given to certain terms used by the classical writers. The first attempt at a wind instrument seems to have been the employment of the shell of some particular fish, or the horn of a quadruped. To this probably succeeded the use of the *Avena*, or single oaten stalk; the *Calamus*, or single reed; and the *Syrinx* or *Fistula*, a number of reeds of different sizes, ranged side by side, each one stopped at the lower end. It was the opinion of Dr. Burney, that such simple instruments as these, in which each pipe is employed to yield but one note, preceded the employment of those which were provided with *foramina*, or holes, and which, by stopping one or more of these holes with the fingers, could be made to yield several notes. When this latter method became known, a great advance in the musical art resulted; and the artificers gradually attained the skill to make such instruments of box-tree, laurel-wood, brass, silver, and even gold.

Flutes or pipes, called *Tibiæ*, were much used in the theatrical exhibitions of the ancients, some of them approaching nearly to the form of a shepherd's pipe, as represented in old pictures, and indeed all of them bearing more resemblance to a flageolet than to a modern flute. But with regard to the instrument now called a mouth-organ, it does not appear to have been similarly employed. It is a circumstance not a little remarkable, that the god Pan is almost invariably represented as playing on this instrument; a fact which, whatever may have been its source, is strongly indicative of the familiar use of such an instrument among the early Greeks. In some of the pictures wherein Pan is introduced, the syrinx on which he appears to be playing, is composed of tubes or pipes having a square sectional area; while in others the pipes are of cylindrical form. In the cut at the end of this article, the pipes are six in number, and of a square form. This representation is taken from an ancient basso-relievo of Greek sculpture, in the Giustiniani Palace at Rome, the sculpture pourtraying the nursing of Jupiter by Amalthea. Pan is holding the syrinx in his left hand, while in his right he grasps a horn, resembling the *shawm*, represented upon the Arch of Titus, among the instruments supposed to have been copied from those brought by this emperor from Jerusalem.

A French writer of the last century relates his having seen at Rome, on a monument in the Farnese Palace, a syrinx with eleven pipes; the first five being of equal lengths, and consequently producing notes of the same pitch; with six others of equal diameter, but of different lengths from the first five, "I confess," says he, "that I am unable to conceive the use of the five first reeds or pipes of the same length for no two of them could be made to sound at once. Is it not possible that these

five pipes were half tones, and differed from each other in length so little, as to seem all of a length? or perhaps they differed in diameter, and may have all produced different tones, though of equal length." But to this supposition it has been objected, that the ancient Greeks had no succession of regular semitones in their musical scale.

Without dwelling longer on the early history of the syrinx,—except to remark that this word is the Greek name for the instrument, that *Fistula Panis* is the Latin name, that *Pan's Pipes* is the English translation of this latter name, and that *mouth-organ* is a name in some degree expressive of the mode in which the instrument is played,—we will describe the acoustical principles on which this instrument acts.

When we blow into an open tube, that is, a tube of cylindrical bore with both ends open, we merely send a forcible current of air from one end of the tube to the other, and produce a *wind*, which is nothing more than a slightly audible agitation of the air. But when one end of the tube is stopped, and we blow into the open end in an oblique manner, with the lips compressed, so as to give a forcible impetus to the breath, a musical *note* results, which is more or less pleasing according to circumstances. Now the difference between a *sound*, such as that resulting from the mere emission of breath, and a musical *note*, consists in this, that in the latter case a current of air is set into regular vibration, performing a certain number of regular oscillatory movements in a certain space of time. It has been found by experiment, that a note having the same pitch as the middle A of the treble clef, is the result of 420 vibrations in a second,—a number indicating an astonishing degree of rapidity in the successive changes in the conditions of the air.

The vibrations here spoken of may be excited either by the agitation of a musical string, or of a column of air in a pipe; the pitch depending on the absolute frequency of vibration, and not upon the manner in which those vibrations are excited. In the case now before us, we blow in a tube, the lower end of which is stopped, and thus excite a rapid oscillatory motion of the particles of air within the tube, which motion is communicated to the external air, and thence to the ear.

But it is a very remarkable part of the phenomenon, and one on which the construction of the mouth-organ mainly depends, that the pitch of the note resulting from these vibrations varies with the length of the pipe; a shorter pipe yielding a more acute or elevated tone than a long one. The mode in which this difference arises is as follows. The vibration of the column of air in the tube, takes a certain time to travel to a certain distance,—viz., at the rate of 1125 feet per second; so that the time which it takes to travel from end to end of the tube will depend simply on the length of the tube, or on the proportion which that length bears to 1125 feet. Consequently a short tube permits the transference of this agitation from end to end, in a shorter time than a long tube; and, as a consequence of this, the repetition or succession of these impulses occurs with greater rapidity. The air will vibrate twice as fast in one tube as in another tube of twice the length; because the agitation has only half the distance to travel in each separate vibration.

There is a curious connexion between the relative lengths of two pipes, and the relative pitch of the notes which are yielded by them. Let us suppose that we have one which yields the A before mentioned, that is, the note resulting from 420 vibrations in a second. If the other be of such a length as to give 840 vibrations in a second (and this will result if, other things being the same, it be only half as long as the other); then the note yielded will be A, one octave higher than the A of the other pipe. If the second one be so much longer that it only gives 210 vibrations in a second, then it yields a note one octave lower than the A first spoken of, and two octaves lower than the other A. But if the lengths of the two pipes be in any less simple proportion, the notes produced will form intermediate steps in the musical scale; thus 256 vibrations in a second, being equal to $\frac{4}{5}$ of 420, will yield the note C, a major-sixth (in musical language) below the former. If we consider this C as a kind of standard note, we shall find that the following fractions, representing the comparative frequency of vibration, 1, $\frac{9}{8}$, $\frac{5}{4}$, $\frac{4}{3}$, $\frac{3}{2}$, $\frac{5}{3}$, $\frac{15}{8}$, 2; or the numbers 256, 288, 320, 341$\frac{1}{3}$, 384, 416$\frac{2}{3}$, 480, 512, will represent the vibrations necessary to produce the succession of notes of the natural scale, C, D, E, F, G, A, B, C. By producing a number of vibrations greater than any here indicated, we shall produce a higher note; and with a less number, a lower note.

On these principles the *mouth-organ* is constructed. It consists of a number of hollow canes or reeds, ranged side by side, and secured by cross bands of cane. The bottom of each pipe is stopped, either by one of the natural joints of the cane, or by wax or some similar substance; while the upper end is open. The lengths of the pipes decrease gradually from one end to the other, the longer being also generally the wider pipes. This increase of diameter is intended, not so much to affect the pitch of the note, as to give a greater roundness and richness to the tone of the lower notes. The length of the pipe is, as before stated, the circumstance which principally regulates the pitch; and this length is arranged on the principles just explained. It is very probable that the maker of the instrument is ignorant of the principles on which he is proceeding; but his proceedings are not the less governed by principles. He endeavours so to regulate the lengths of the pipes as to produce the succession of notes forming the regular Diatonic scale; and in so doing, he finally settles on such lengths as will will yield the numbers of vibrations indicated above, or at least, the *proportions* of those numbers; for the actual number will depend on the octave which forms the main part of the instrument.

The mouth-organ is, from its nature, not very likely to get out of order, since the lengths of the pipes, on which the pitch of the notes depends, are less likely to yield from changes of temperature than the other dimensions. It must be obvious to any one at all acquainted with the action of organ pipes in general, that the reeds of a mouth-organ bear a considerable resemblance to them, inasmuch as they produce sounds by the longitudinal vibration of a column of air. Hence the popular name of the instrument.

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